

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor ~~comprising~~ having a sensor element including a solid electrolyte and a pair of electrodes ~~placed on~~ interposing said solid electrolyte therebetween so that an element current flows through said sensor element ~~in~~ at a level corresponding ~~relation~~ to a concentration of a specific component in a detection gas ~~concentration~~ whenever a voltage is applied to said sensor element, ~~with the applied voltage being controlled on the basis of an applied voltage characteristic defined linearly and said specific component concentration in a gas to be detected being detected in a wide range on the basis of an output of said element current, said applied voltage characteristic being set on the basis of a width of a limiting current region on each concentration level in a gas concentration detection range~~ said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied

voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the detection gas starts, for each of levels of the specific component concentration, the voltage level range of the limiting current region for each level of the specific component concentration being changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element,

adjusts the applied voltage line such that the applied voltage line passes through the limiting current region set for each level of the specific component concentration within the gas concentration detection range,

adjusts the voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the specific component concentration such that the voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range,

adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration,
and

controls the applied voltage according to the applied voltage line.

2. (Canceled)

3. (Currently Amended) The apparatus according to claim 1, wherein said applied voltage control unit specifies an upper limit point or one a point on said limiting current region in the vicinity of said upper limit point on the limiting current region set for a minimum level of the

specific component concentration in said gas concentration detection range ~~is specified~~ and ~~specifies~~ a lower limit point or ~~one a point on said limiting current region~~ in the vicinity of said lower limit point on the limiting current region set for a maximum level of the specific component concentration in said gas concentration detection range ~~is specified, with an~~ and sets ~~the~~ applied voltage line ~~being set as said applied voltage characteristic~~ to pass through said points specified.

4. (Canceled)

5. (Currently Amended) The apparatus according to claim 1, wherein said applied voltage control unit divides said gas concentration detection range ~~is divided~~ into a plurality of portions, and specifies, in each detection range portion, an upper limit point or ~~one a point on said limiting current region~~ in the vicinity of the upper limit point on the limiting current region set for a minimum level of the detection range portion, ~~in each detection range portion is specified and~~ specifies, in each detection range portion, a lower limit point or ~~one a point on said limiting current region~~ in the vicinity of the lower limit point on the limiting current region set for a minimum level of the detection range portion ~~in each detection range portion is specified, with an~~ and sets the ~~serving as said applied voltage line characteristic being set~~ to pass through said points specified.

6. (Canceled)

7. (Currently Amended) The apparatus according to claim 1, wherein said applied voltage control unit determines said limiting current ~~region~~ regions ~~is determined~~ on the condition that a variation of said element current is below a predetermined quantity, and sets said applied voltage line characteristic ~~is set~~ to pass through an intermediate point of said each limiting current region.

8.-10. (Canceled)

11. (Currently Amended) The apparatus according to claim 1, wherein said apparatus is made to detect a specific component concentration in an exhaust gas emitted from a combustion engine, and said applied voltage control unit sets a ~~said limiting current region is set between a first voltage point at which, when said applied voltage to said sensor element is increased, an output of an electromotive force coming into balance with said applied voltage starts and a second voltage point at which said element current increases due to the~~ a residue of a reaction-hard component of unburned components contained in said exhaust gas ~~to be detected as the second voltage point for each limiting current region.~~

12. (Canceled)

13. (Currently Amended) The apparatus according to claim 11, wherein said applied voltage control unit specifies an intermediate point between said first and second voltage points for each limiting current region ~~is specified to set an~~ cause the applied voltage line to pass through the intermediate points ~~as said applied voltage characteristic.~~

14.-16. (Canceled)

17. (Currently Amended) The apparatus according to claim 1, wherein, on voltage-current (V-I) coordinates representing the relationship between said applied voltage and said element current therein, said applied voltage control unit makes an inclination (I/V) of an the applied voltage line serving as said applied voltage characteristic is made smaller than an inclination (I/V) of a resistance governing region determined in accordance with a direct-current internal resistance of said sensor element.

18. (Canceled)

19. (Currently Amended) The apparatus according to claim 1, wherein said applied voltage control unit sets different applied voltage characteristics ~~are set~~ in a gas concentration detection range in which widths of the limiting current regions are approximately equal to each other and in a gas concentration detection range in which widths of the limiting current regions are different from each other.

20.-22. (Canceled)

23. (Currently Amended) The apparatus according to claim ~~21~~ 1, wherein said applied voltage control unit adjusts the temperature-considered voltage level range of the limiting current region such that a voltage level range of the limiting current region determined by an a sensor

output characteristic at a minimum temperature in a temperature range actually attainable in a using environment of said sensor element and a voltage level range of the limiting current region determined by an a sensor output characteristic at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range, for each level of the specific component concentration and sets the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration ~~therein are employed so that said applied voltage line is set to pass through a region in which limiting currents of said output characteristics overlap.~~

24. (Canceled)

25. (Currently Amended) The apparatus according to claim 1, wherein said applied voltage control unit adjusts the temperature-considered voltage level range of the limiting current region such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic thereof of said sensor element after variation with time are used so that an applied voltage line is set to pass through a region in which limiting current regions of said output characteristics overlap ~~overlap with each other within the temperature-considered voltage level range, for each level of the specific component concentration and sets the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration.~~

26. (Canceled)

27. (Currently Amended) The apparatus according to claim 25, wherein said estimated output characteristic after the variation with time is an estimated output characteristic at a deterioration tolerance limit permitting ~~the~~ a use of an output of said element current.

28. (Canceled)

29. (Currently Amended) The apparatus according to claim 1, wherein a sensor characteristic line and ~~an~~ the applied voltage line are set so as not to intersect with each other in a region outside a gas concentration detection range defined in advance.

30. (Canceled)

31. (Currently Amended) The apparatus according to claim 1, ~~wherein~~ further comprising excess current detecting means ~~is provided to detect that detects that~~ said element current ~~is to be~~ outside a range defined in advance, and said applied voltage characteristic is changed when said excess current detecting means detects said element current in the exterior of the defined range.

32. (Canceled)

33. (Currently Amended) The apparatus according to claim 31, wherein, when said excess current detecting means detects ~~that~~ said element current is to be outside the defined range, said applied voltage control unit changes said applied voltage characteristic ~~is made to be changed~~ to a voltage limiting applied voltage characteristic ~~for suppressing~~ to suppress excess voltage application to said sensor element, while a timing of the change of said applied voltage characteristic is delayed at the detection of said element current outside the defined range.

34. (Canceled)

35. (Currently Amended) The apparatus according to claim 1, wherein said applied voltage control unit has an applied voltage control circuit ~~made to feedback control that feedback-controls~~ the applied voltage on the basis of said element current and controls the applied voltage on the basis of the set applied voltage characteristic.

36. (Canceled)

37. (Currently Amended) The apparatus according to claim 35, wherein said applied voltage control circuit includes voltage change regulating means ~~for regulating~~ that regulates a change of the applied voltage.

38. (Canceled)

39. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor ~~comprising~~ having a sensor element including a solid electrolyte and a pair of electrodes ~~placed on~~ interposing said solid electrolyte therebetween so that an element current flows through said sensor element ~~in at a level~~ corresponding relation to a concentration of a specific component in a detection gas concentration whenever a voltage is applied to said sensor element, ~~with the applied voltage being controlled on the basis of an applied voltage characteristic defined linearly and said specific component concentration in a gas to be detected being detected in a wide range on the basis of an output of said element current, and in a predetermined concentration range, a low voltage side characteristic defined by connecting low voltage side end points of limiting current regions on concentration levels and a high voltage side characteristic defined by connecting high voltage side end points of the same limiting current regions thereon are defined so that said applied voltage characteristic is set on the basis of an intermediate inclination between the inclinations of said low voltage and high voltage side characteristics~~ said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied

voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the detection gas starts, for each of levels of the specific component concentration, the voltage level range of the limiting current region for each level of the specific component concentration being changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element,

adjusts the applied voltage line in a predetermined concentration range of the specific component such that an inclination of the applied voltage line is placed between an inclination of a low-voltage side line defined by connecting the first voltage points of the limiting current regions and an inclination of a high-voltage side line defined by connecting the second voltage points of the limiting current regions,

adjusts the voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the specific component concentration such that voltage level ranges of the limiting current region in temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range,

adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration,
and

controls the applied voltage according to the applied voltage line.

40.-42. (Canceled)

43. (Currently Amended) The apparatus according to claim 39, wherein the apparatus is a gas concentration detecting apparatus which is made to detect a specific component concentration of an exhaust gas emitted from a combustion engine, and said low-voltage side ~~characteristic line~~ line is defined by a voltage point at which, when the applied voltage to said sensor element is increased, an output of an electromotive force coming into balance with respect to the applied voltage starts, while said high-voltage side ~~characteristic line~~ line is defined by a voltage point at which said element current increases due to the residue of a reaction-hard component of unburned components contained in said gas ~~to be detected~~.

44. (Canceled)

45. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor ~~comprising~~ having a sensor element including a solid electrolyte and a pair of electrodes ~~placed on~~ interposing said solid electrolyte therebetween so that an element current flows through said sensor element in at a level corresponding ~~relation to a~~ concentration of a specific component in a detection gas concentration whenever a voltage is applied to said sensor element, ~~with the applied voltage being controlled on the basis of an applied voltage characteristic defined in advance and said specific component concentration in a gas to be detected being detected in a wide range on the basis of an output of said element current, the applied voltage to said sensor element is controlled between a voltage point at which, when the applied voltage to said sensor element is increased, an output of an electromotive force coming into balance with respect to the applied voltage starts and a voltage point at which decomposition of water contained in a gas to be detected starts, said apparatus comprising:~~

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage in advance,
sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the detection gas starts, for each of levels of the specific component concentration, the voltage level range of the limiting current region for each level of the specific component concentration being changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element,

adjusts the voltage level range of limiting current region to a temperature-considered voltage level range for each level of the specific component concentration such that voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range,

adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration,
and

controls the applied voltage according to the applied voltage line.

46. (Canceled)

47. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor ~~comprising~~ having a sensor element including a solid electrolyte and a pair of electrodes ~~placed on~~ interposing said solid electrolyte therebetween so that an element current flows through said sensor element ~~in~~ at a level corresponding ~~relation~~ to a concentration of a specific component in a detection gas ~~concentration~~ whenever a voltage is applied to said sensor element, ~~with the applied voltage being controlled on the basis of an applied voltage characteristic defined in advance and said specific component concentration in a gas to be detected being detected in a wide range on the basis of an output of said element current, the applied voltage is controlled in a region in which limiting current regions overlap in a plurality of sensor output characteristics different in temperature condition of the sensor element from each other,~~ said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage in advance,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the detection gas starts, for each of levels of the specific component concentration, the voltage level range of the limiting current region for each level of the specific component concentration being changeable with a temperature of the sensor

element due to a sensor output characteristic changing with the temperature of the sensor element,

adjusts the voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the specific component concentration such that a voltage level range of the limiting current region determined by a sensor output characteristic at a minimum temperature in a temperature range actually attainable in a using environment of said sensor element and a voltage level range of the limiting current region determined by a sensor output characteristic at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range,

adjusts the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration,
and

controls the applied voltage according to the applied voltage line.

48. (Canceled)

49. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor ~~comprising~~ having a sensor element including a solid electrolyte and a pair of electrodes ~~placed on~~ interposing said solid electrolyte therebetween so that an element current flows through said sensor element ~~in~~ at a level corresponding ~~relation~~ to a concentration of a specific component in a detection gas concentration whenever a voltage is applied to said sensor element, ~~with the applied voltage being controlled on the basis of an applied voltage characteristic defined in advance and said specific component concentration in a~~

~~gas to be detected being detected in a wide range on the basis of an output of said element current, an initial output characteristic of said sensor element and an estimated output characteristic thereof after variation with time are used so that the applied voltage is controlled in a region in which limiting current regions of said output characteristics overlap, said apparatus comprising:~~

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage in advance,
sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the detection gas starts, for each of levels of the specific component concentration, a voltage level range of the limiting current region for each level of the specific component concentration being dependent on an output characteristic of the sensor element,

adjusts the voltage level range of the limiting current region to an adjusted voltage level range for each level of the specific component concentration such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the adjusted voltage level range,

adjusts the applied voltage line so as to pass through the adjusted voltage level range of
the limiting current region for each level of the specific component concentration, and
controls the applied voltage according to the applied voltage line.

50. (Currently Amended) The apparatus according to claim 49, wherein said estimated output characteristic after the variation with time is an estimated output characteristic at a deterioration tolerance limit permitting ~~the~~ a use of an output of said element current.

51. (Currently Amended) The apparatus according to claim 1, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio A/F₂₀ equal to 20 or more.

52. (Canceled)

53. (Currently Amended) The apparatus according to claim 39, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio A/F₂₀ equal to 20 or more.

54.-58. (Canceled)

59. (Original) The apparatus according to claim 1, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

60. (Canceled)

61. (Original) The apparatus according to claim 39, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

62.-66. (Canceled)

67. (Currently Amended) The apparatus according to claim 1, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio A/F11 equal to 11 or less.

68. (Canceled)

69. (Currently Amended) The apparatus according to claim 39, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas

emitted from a combustion engine, and a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio A/F11 equal to 11 or less.

70.-74. (Canceled)

75. (New) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween so that an element current flows through said sensor element at a level corresponding to a concentration of a specific component in a detection gas whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the detection gas starts, for each of levels of the specific component concentration, a voltage level range of the limiting current region for each

level of the specific component concentration being dependent on an output characteristic of the sensor element,

adjusts the applied voltage line such that the applied voltage line passes through the limiting current region set for each level of the specific component concentration within the gas concentration detection range,

adjusts the voltage level range of the limiting current region to an adjusted voltage level range for each level of the specific component concentration such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the adjusted voltage level range,

adjusts the applied voltage line so as to pass through the adjusted voltage level range of the limiting current region for each level of the specific component concentration, and

controls the applied voltage according to the applied voltage line.

76. (New) The apparatus according to claim 75, wherein said applied voltage control unit specifies an upper limit point or a point in the vicinity of said upper limit point on the limiting current region set for a minimum level of the specific component concentration in said gas concentration detection range and specifies a lower limit point or a point in the vicinity of said lower limit point on the limiting current region set for a maximum level of the specific component concentration in said gas concentration detection range, and sets the applied voltage line to pass through said points specified.

77. (New) The apparatus according to claim 75, wherein said applied voltage control unit divides said gas concentration detection range into a plurality of portions, and specifies, in each detection range portion, an upper limit point or a point in the vicinity of the upper limit point on the limiting current region set for a minimum level of the detection range portion specifies, in each detection range portion, a lower limit point or a point in the vicinity of the lower limit point on the limiting current region set for a minimum level of the detection range portion, and sets the applied voltage line to pass through said points specified.

78. (New) The apparatus according to claim 75, wherein said applied voltage control unit determines said limiting current regions on the condition that a variation of said element current is below a predetermined quantity, and sets said applied voltage line to pass through an intermediate point of each limiting current region.

79. (New) The apparatus according to claim 75, wherein said apparatus is made to detect a specific component concentration in an exhaust gas emitted from a combustion engine, and said applied voltage control unit sets a point at which said element current increases due to a residue of a reaction-hard component of unburned components contained in said exhaust gas as the second voltage point for each limiting current region.

80. (New) The apparatus according to claim 79, wherein said applied voltage control unit specifies an intermediate point between said first and second voltage points for each limiting current region to cause the applied voltage line to pass through the intermediate points.

81. (New) The apparatus according to claim 75, wherein, based on voltage-current (V-I) coordinates representing the relationship between said applied voltage and said element current therein, said applied voltage control unit makes an inclination (I/V) of the applied voltage line smaller than an inclination (I/V) of a resistance governing region determined in accordance with a direct-current internal resistance of said sensor element.

82. (New) The apparatus according to claim 75, wherein said applied voltage control unit sets different applied voltage characteristics in a gas concentration detection range in which widths of the limiting current regions are approximately equal to each other and in a gas concentration detection range in which widths of the limiting current regions are different from each other.

83. (New) The apparatus according to claim 75, wherein said applied voltage control unit is adapted to again adjust the adjusted voltage level range of the limiting current region to a temperature-considered voltage level range for each level of the specific component concentration such that voltage level ranges of the limiting current region in temperature conditions of the sensor element overlap with one another within the temperature-considered voltage level range, and is adapted to adjust the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region.

84. (New) The apparatus according to claim 83, wherein said applied voltage control unit is adapted to adjust the limiting current region to the temperature-considered voltage level range for each level of the specific component concentration such that a voltage level range of

the limiting current region determined by a sensor output characteristic at a minimum temperature in a temperature range actually attainable in a using environment of said sensor element and a voltage level range of the limiting current region determined by a sensor output characteristic at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range, and is adapted to set the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the specific component concentration.

85. (New) The apparatus according to claim 75, wherein said estimated output characteristic after the variation with time is an estimated output characteristic at a deterioration tolerance limit permitting a use of an output of said element current.

86. (New) The apparatus according to claim 75, wherein a sensor characteristic line and the applied voltage line are set so as not to intersect with each other in a region outside a gas concentration detection range defined in advance.

87. (New) The apparatus according to claim 75, further comprising excess current detecting means that detects said element current to be outside a range defined in advance, and said applied voltage characteristic is changed when said excess current detecting means detects said element current in the exterior of the defined range.

88. (New) The apparatus according to claim 87, wherein, when said excess current detecting means detects said element current to be outside the defined range, said applied voltage

control unit changes said applied voltage characteristic to a voltage limiting applied voltage characteristic to suppress excess voltage application to said sensor element, while a timing of the change of said applied voltage characteristic is delayed at the detection of said element current outside the defined range.

89. (New) The apparatus according to claim 75, wherein said applied voltage control unit has an applied voltage control circuit that feedback-controls the applied voltage on the basis of said element current and controls the applied voltage on the basis of the set applied voltage characteristic.

90. (New) The apparatus according to claim 89, wherein said applied voltage control circuit includes voltage change regulating means that regulates a change of the applied voltage.

91. (New) The apparatus according to claim 75, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

92. (New) The apparatus according to claim 75, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

93. (New) The apparatus according to claim 75, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

94. (New) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween so that an element current flows through said sensor element at a level corresponding to a concentration of a specific component in a detection gas whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the detection gas starts, for each of levels of the specific component concentration, a voltage level range of the limiting current region for each

level of the specific component concentration being dependent on an output characteristic of the sensor element,

adjusts the applied voltage line in a predetermined concentration range of the specific component such that an inclination of the applied voltage line is placed between an inclination of a low-voltage side line defined by connecting the first voltage points of the limiting current regions and an inclination of a high-voltage side line defined by connecting the second voltage points of the limiting current regions,

adjusts the voltage level range of the limiting current region to an adjusted voltage level range for each level of the specific component concentration such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the adjusted voltage level range,

adjusts the applied voltage line so as to pass through the adjusted voltage level range of the limiting current region for each level of the specific component concentration, and

controls the applied voltage according to the applied voltage line.

95. (New) The apparatus according to claim 94, wherein the apparatus is a gas concentration detecting apparatus which is made to detect a specific component concentration of an exhaust gas emitted from a combustion engine, and said low-voltage side line is defined by a voltage point at which, when the applied voltage to said sensor element is increased, an output of an electromotive force coming into balance with respect to the applied voltage starts, while said

high-voltage side line is defined by a voltage point at which said element current increases due to the residue of a reaction-hard component of unburned components contained in said gas.

96. (New) The apparatus according to claim 94, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

97. (New) The apparatus according to claim 94, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

98. (New) The apparatus according to claim 94, wherein said apparatus is made to detect an air-fuel ratio on the basis of an oxygen concentration in an exhaust gas emitted from a combustion engine, and a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.